Adaptive radio propagation model for maximizing performance efficiency in smart city disaster management application

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ABSTRACT

Climate change poses several environmental threats like floods to urban environment; thus, effective and reliable communication of emergency information is needed during massive breakdown of network infrastructure. This paper presents a mobile adhoc network (MANETs) based effective information such as calls, image, and videos communication system that is compatible with current 3GPP and 5G communication network. Here in maintaining connectivity the information is communicated between different MANET nodes in a multi-hop manner. However, designing radio propagation is challenging considering higher local emergency request congestion at different terrain with varying speed of users. The current radio propagation model is designed without considering the effect of line-of-sight between communicating device and are not adaptive to different environment considering urban disaster management environment. This paper develops an adaptive radio propagation (ARP) model namely expressway, city and semi-urban. Then, in reducing congestion and improving network performance efficiency the work introduced an adaptive medium access control (AMAC) protocol. The MAC incorporates a dynamic network controller (DNC) to optimize the contention window size in dynamic manner according to current traffic demands. The AMAC protocol achieves much improved throughput with lesser packet loss in comparison with existing MAC (EMAC) model considering different radio propagation model introduced in this work.

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1. INTRODUCTION

Urban disaster management system is a multi-stakeholder framework for mitigating, preparing for, responding to, and recovering from disasters in urban areas [1] as shown in Figure 1. It includes risk assessment and planning, early warning systems, emergency response coordination, communication and information management, evacuation and shelter management, search and rescue operations, recovery and reconstruction efforts, and community engagement and education [1]. By collaborating and integrating resources, expertise, and technologies, the system aims to minimize loss of life, reduce damage to property and infrastructure, and enhance the resilience of urban communities in the face of disasters [1]. In an urban disaster management system, video transmission is crucial for real-time visual information, decision-making, and coordination among stakeholders [2]. It involves capturing, transmitting, and receiving video content to support disaster management operations. Video surveillance provides real-time feeds for situation assessment, while remote assessment allows monitoring of inaccessible areas using cameras on unmanned aerial vehicles [3]. Live video streaming facilitates rescue operations and resource allocation. Video conferencing enables real-time communication and collaboration among dispersed stakeholders. Video transmission supports training, public information dissemination, and documentation of disaster events for analysis and future planning [4]. Effective video transmission ensures timely access to visual information, enhancing communication, collaboration, and informed decision-making in disaster response and recovery efforts [5].

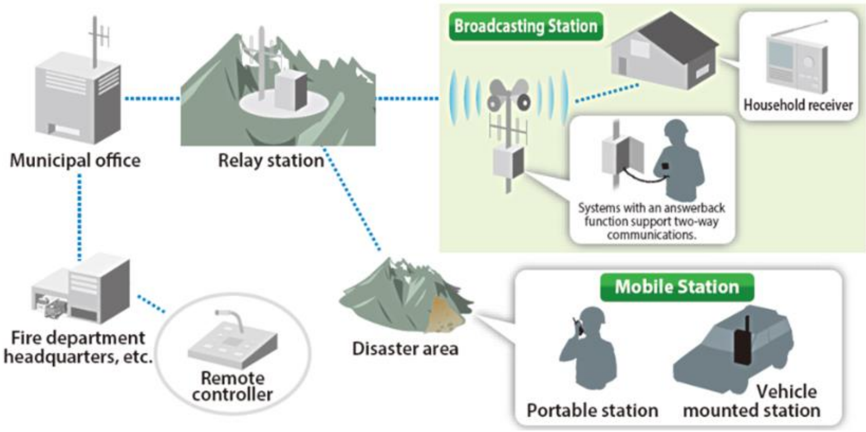

Figure 1. Urban disaster prevention radio system [1]

Moreover, video transmission in urban disaster management systems faces challenges due to limited network infrastructure [6], bandwidth constraints [7], line-of-sight obstructions [8], mobility in dynamic environments [9], and signal interference [10]. These challenges can hinder reliable and timely video transmission, impacting communication and coordination efforts during disasters. Addressing these challenges requires innovative solutions such as adaptive transmission technique [11], optimized network infrastructure deployment [12], robust error correction mechanism [13], and efficient bandwidth management algorithm [14]. Overcoming these challenges is crucial to ensure effective video transmission that supports situational awareness, decision-making, and coordination in urban disaster management operations. Moreover, in recent years, video transmission in an urban disaster management system has been hampered by mobility patterns and line-of-sight obstacles. To address these challenges, the system must adapt to mobility patterns [15], employ strategies like relay nodes [16] or multi-hop transmission [17] to overcome line-of-sight obstacles, and dynamically adjust routing protocols to accommodate changes in the network topology. Effective bandwidth management, using adaptive bitrate streaming, ensures continuous video playback and optimal transmission performance. Accurate signal propagation modeling aids in infrastructure deployment and optimization. Multi-modal communication, utilizing different wireless technologies, can enhance video transmission when line-of-sight is obstructed. By considering these factors and employing adaptive transmission strategies, an urban disaster management system can achieve effective video transmission, facilitating real-time visual information exchange, coordination, and decision-making in complex urban disaster scenarios.

The need for an adaptive propagation model in urban disaster management arises from the challenges posed by mobility patterns and line-of-sight obstacles. Most of the existing models address these challenges by adjusting transmission parameters and routing algorithms to enable continuous video transmission in dynamic environments. They employ strategies like relay nodes or multi-hop transmission to overcome line-of-sight limitations caused by buildings and structures. The existing models ensure reliable and timely communication by adapting to the dynamic network topology and optimizing bandwidth utilization through techniques like adaptive bitrate streaming. By enhancing system resilience, the model enables effective and uninterrupted video communication, facilitating situational awareness, decision-making, and coordination among stakeholders in urban disaster scenarios. The work introduces a performance maximization strategy to design adaptive media access control (MAC).

- The work introduced an adaptive radio propagation model by incorporating obstacles in line-of-sight.
- The model introduced a dynamic network controller to optimize the contention window size according to traffic level to enhance the throughput of network.
- The obstacle effect of adaptive radio propagation (ARP) model is modelled for different radio propagation environment such as expressway, city and semi-urban.

– The adaptive medium access control (AMAC) protocol improves throughput and reduces packet loss for provisioning video-based disaster management application.

The manuscript is arranged as follows: Section 2 discusses various existing methodologies modelled to enhanced radio propagation for better disaster management. Section 3 discusses how the proposed adaptive MAC protocols work and how the proposed radio propagation model is adaptive in nature. Section 4 discusses the result attained by proposed and existing MAC models. The research significance and future enhancement is provided in last section.

2. LITERATURE SURVEY

In this section, different existing methodologies for the radio propagation, MAC optimizations and routing protocols for provisioning effective disaster management application using the MANETS have been discussed. In [18], they have presented a delay-energy-quality-aware multipath transmission control protocol (DEAM-TCP) for providing an energy-efficient model for the real-time video transmission. This work presented a model which can characterize the delay constrained energy-quality tradeoff for the delivery of the video in a heterogenous environment. Also, they have presented an algorithm for minimizing the energy consumption for transmitting the video in a given deadline. They have simulated their model on the Exata platform. The outcomes show that the proposed model obtains superior performance in terms of streaming rate and energy consumption. In [19], they have presented a protocol called as fault-tolerant ad-hoc routing (FT-AORP) which focusses on providing a reliable path for the MANET nodes (MNs) for transmission of data. This work has provided two paths for transmitting the data which will help to reduce the packet failure, hence, maximizing the fault tolerance. For evaluating their protocol, the OMNeT++ simulator has been used. This protocol has been evaluated in terms of the total network nodes present, speed of the node, and rate of data transmission. The results shows that the protocol enhanced the packet delivery ratio (PDR), decreased the end-to-end delay (EED) and reduced energy consumption for the transmission of data in comparison to the existing protocols. In [20], they have presented a model for improving the quality-of-service (QoS) for the multimedia applications. This focus of this work was to improve the overall performance of the network. This work considered three main components for enhancing the network, i.e., threshold-based transmission of data, channel and queuing model. The results were evaluated in terms of packet delivery ratio (PDR), transmission rate, throughput and bandwidth efficiency. In comparison to existing works, the outcomes show better results.

In [21], they have proposed a multipath routing method using genetic and hill climbing algorithm (GAHC) for selecting the best path for transmission of data. Also, they have used the improved version of fuzzy c-means algorithm which predicted an optimal route using trustable parameters. For evaluation, they have used different metrics such as connection, latency, and throughput. The results show that the algorithm consumes only 0.10m joules of energy and 0.004 msec delay time for transmission of data. Also, this algorithm achieved highest throughput of 0.85 bits. In [22], they have proposed a model called as media-aware network-elements (MANE) for improving the transmission of video in the network. This work provides a novel approach by employing an experimental assessment method to determine the optimal video qualities for a given network environment. Using an experimental approach, they evaluated the adaption parameters for scalable video streaming across a wireless network. For evaluating their model, they have used bandwidth, mobility and motion level of video sequence metric. The simulation was conducted with OMNet++. In [23], they proposed method for the distribution of video packets called as CLONE for the VANETs. First this work measures the delay and data delivery ratio using their proposed indicator known as current-network-quality information (CNQI). The CNQI of each node is used to determine which cloned access points which will be used to store video data packets and route to the target vehicle. The outcomes demonstrate better QoS and QoE in comparison to prior work. All the above existing work have mainly focused to provide better performance for the video transmission. Also, all these works have considered to reduce the energy consumption and increase throughput.

In [24], this work has focused to provide better network for the calling services during disaster management scenarios. This work provides a solution to the network when all the network infrastructure is not working. Hence for this, they have proposed a protocol called as 5G standalone service (5G-SOS). In this work, devices act as a decentralized network with the goal of maximizing the probability of a timely emergency call transfer. The protocol has been evaluated in terms of End-to-End Latency, energy consumption, control of network traffic and rate of successful transmission. In [25], this study gives a review of the research done on radio propagation channel modeling for a low-altitude unmanned aerial vehicle (UAV) equipped wireless system, including both metrics and simulation-based approaches. In [26], they have presented a review on the radio propagation environments. They have analyzed various machine learning and different algorithms which can provide better transmission of data in the radio propagation environment. While the mentioned works propose various solutions to enhance networking, multimedia transmission, and wireless systems, they also come with some drawbacks. DEAM may require further validation in real-world scenarios beyond simulations [18], and fault-tolerant ad-hoc routing (FT-AORP) reliance on two paths could lead to increased complexity in large networks [19]. The threshold-based approach in the QoS improvement model [20] might not be suitable for all scenarios, and GAHC's utilization of Genetic and Hill Climbing Algorithms could be computationally expensive [21]. MANE's [22] experimental assessment method might not cover all possible network conditions, and CLONE's [23] reliance on cloned access points could introduce scalability challenges. 5G-SOS's decentralized network approach [24] might struggle to handle high traffic loads during emergencies. Hence, to solve all this issue, in the next section a novel methodology has been presented.

3. PROPOSED METHODOLOGY

For maximizing the performance of communication networks during different kind of disasters in smart cities, here, a model called as adaptive radio propagation (ARP) has been presented which considers various mobility patterns present in the urban cities or smart cities such as expressways, city and semi-urban. Furthermore, the ARP model also considers the different kind of obstacles that come in the line-of-sight (LoS) of various communication devices. For optimizing the contention window dynamically during the process of resource optimization and for enhancing the user's total throughput with the least packet loss, this work presents a model called as dynamic network controller (DNC). The DNC helps to reduce the latency during the transmission of packets. Both the ARP and DNC models help to provide better communication network and transmission of data for the applications of disaster management. In the next section the system model of the proposed work has been given.

3.1. System model

The proposed works considers that the mobile ad hoc network (MANET) nodes are able to use the MANET-to-MANET (M2M) communication network and MANER radio towers (MRT) for transmission and communication of data. In this work, the MRT communications are among the high-speed radio-communication network and MANET Nodes (MN), whereas, the M2M communications are only between the MN. Both the M2M and MRT in this work utilize the IEEE 802.11 standards for establishing communication among each other. Furthermore, the proposed DNC model is connected to IEEE 802.11 Access-Points (IEEE-AP). The OpenFlow protocol has been utilized in this work for establishing the communication among the (IEEE-AP) and the DNC. Also, the IEEE-AP flow tables have been included with a suitable flow-entry for transmitting the safety-related data from the requesting-stations to the DNC model. Moreover, the DNC model generates pkt_{out} messages having novel $\mathcal{A}$ values for establishing a connection with the requesting station. The pkt_{out} in this work has been encapsulated using the IEEE-AP in message segments which will be further transmitted to the respective stations.

3.2. Performance maximization

This section presents a model for optimizing the performance of the communication network when transmitting data from one device to another device with varying mobility patterns and multiple obstacles in the line of sight (LoS) during the communication. For maximizing the performance, consider a set of MN, where the users are moving from one region to another region. Also, consider that the MNs have only a homogenous communication network radius defined using S_y which can either use a single MRT or MNs for communication at given instance. Further, consider that the MN sends H packets of N size which passes from the Radio-Propagation (RP) environment using a set of MN represented as $\mathcal{A} = \{1, \dots, A\}$. For describing the average node arrival-rate within a given region, consider $\mathcal{M}$ which can be used for defining the average size of MNs. The $\mathcal{M}$ is assumed to pass from the RP environment using the Poisson-Distribution (PD). Furthermore, the density and speed of the MN can be defined using l and u respectively. The u of the MN having a particular l can be evaluated by (1).

$$u = u_k \left(1 - \frac{l}{l_\uparrow}\right) \tag{1}$$

Where, u_k represents the MN speed under PD. $l_\uparrow$ represents the highest achievable MN density in the RP environment. From this the average size of MNs, $\mathcal{M}$ can be evaluated utilizing the given as (2).

$$\mathcal{M} = lu \tag{2}$$

The highest number of MNs denoted as P which can access the MRT represented as y and MNs for communication can be evaluated by using the floor-function which has been given as (3).

$$P_{\uparrow,y} = \lfloor 2S_{yl_{\uparrow}} \rfloor,\ \forall y \in \mathcal{A} \quad (3)$$

Further, for enhancing the packet transmission in an RP environment, where the environment changes dynamically, for solving this, the AMAC protocol has been proposed. In the AMAC protocol, the time is divided into different segments having equivalent slot-size of δn. For evaluating the total time that a MN will be in a given region utilizing MNs or MRT is defined using the given as (4).

$$N_y = \left\lfloor {}^{2S_y}/_{u\delta n} \right\rfloor \quad (4)$$

For the evaluation of the $\mathcal{N}^{th}$ slot-time, in the case when the MNs are in the communication region of adjacent MNs, then this can be evaluated using the given as (5).

$$\mathcal{V}(y,\mathcal{N}) = \sum_{x=0}^{y-1} N_x + \mathcal{N},\ \ \forall\, \mathcal{N} \in \{1, \dots, N_y\} \quad (5)$$

Where, $N_0 = 0$. Further, the following equation describes how the time-slots are represented on the timeline of the MRT y^{th} device.

$$\mathcal{N}_y = \{\mathcal{V}(y,1), \dots, \mathcal{V}(y, N_y)\} \quad (6)$$

For maximining the performance and providing better efficiency for the communication in the MANET, this work selects the best time-slots which can help to improve the overall systems throughput. Consider a decision maker for the slot-assignments represented as e_{xy} and the throughput achieved by every MN represented as X in the MANET be S_X. In this work, the $e_{X\mathcal{N}}$ will be set as 1 when the slot $\mathcal{N}$ is given to a MN. When the slot $\mathcal{N}$ is not given to MN, then the $e_{X\mathcal{N}}$ will be set as 0. Hence, this problem is defined as throughput gain which is defined as given as (7).

$$\max_{E} \sum_{X}^{R} S_X \quad (7)$$

Where, R represents the total size of the MNs in the MANET. Also, the constraints for the slot-assignment can be defined using the given as (8).

$$\sum_{X}^{R} e_{X\mathcal{N}} = 1 \quad \forall y \quad (8)$$

Hence, in this work, we evaluate the total throughput achieved by the X using the slot-assignment. Consider V_X which represents the allocated slots to the MNs x and $l_{X\mathcal{N}}$ which represents the likelihood of the slot $\mathcal{N}$ which is accessible by X. This work considers that the $l_{X\mathcal{N}}$ is not reliant on the likelihood of the slot $\mathcal{N}$. Hence, from this the S_X can be evaluated using given as (9).

$$S_X = 1 - \prod_{\mathcal{N}\in V_{\mathcal{N}}} l'_{X\mathcal{N}} = 1 - \prod_{\mathcal{N}=1}^{T} (l'_{X\mathcal{N}})^{e_{X\mathcal{N}}} \quad (9)$$

Where, $1 - \prod_{\mathcal{N}\in V_X} l'_{X\mathcal{N}}$ represents the likelihood that there is at least a slot available for every X. Further, the $l'_{X\mathcal{N}}$ represents the likelihood that the slot is not available for the X which is evaluated using given as (10).

$$l'_{X\mathcal{N}} = 1 - l_{X\mathcal{N}} \quad (10)$$

The maximum S_X which can be achieved for different RP environments by considering different data rates will be 1. This happens because the MNs can only utilize a single slot for a given time. In the next section, the ARP model has been presented.

3.3. Adaptive radio propagation model

In a RP environment, different shadowing component, path loss, and shading are present. Hence, to address all the issues of these components, an effective model is required for the improvement of the packet transmission. Hence, in this section, the ARP model has been presented which solves the issues of channel attenuation and path loss. Consider a time-slot represented as n. The bandwidth for the a given n can be evaluated by the given as (11).

$$c_n = C \log_2 \left({}^{G}/_{P_0 C r_n^{\alpha}} + 1 \right) \tag{11}$$

Where, C represents the MANET bandwidth, G represents the power required for communication, P_0 represents the spectral density of power having zero gaussian-noise, r_n represents the distance among the MNs which are communicating at the given slot n and α represents the path-loss. For calculating the α given in the in (11), as given in [21], the path-loss and the log normal-shadowing component is evaluated in this work by considering the Signal-to-Noise Ratio (SNR) $(r)_{dB}$ having the distance r which separates the sender and receiver. Hence, from this the α is evaluated using given as (12).

$$\alpha(r)_{dB} = \mathcal{P}_t - \mathcal{PL}(r_0) - 10_n \log_{10}\left({}^{r}/_{r_0} \right) - \mathcal{X}_\sigma - \mathcal{P}_n \tag{12}$$

Where, $\mathcal{P}_t$ represents the power essential for processing the packets, $\mathcal{PL}(r_0)$ represents that path-loss for a given distance which is apart from r_0, $\mathcal{X}_\sigma$ represents the zero-mean Gaussian Randomized Parameter having the standard deviation σ, and $\mathcal{P}_n$ represents the level of noise in decibel watts. In this work, to solve the problem of multiple obstacles in the LoS, this work solves this issue by enhancing the log-normal shadowing component [22], [23] For developing an obstacle-aware RP model, in this work, we consider the adjacent MNs as the LoS obstacles. Consider MNs which would get affected because of the presence of obstacles during the transmission of data from the MNs x to the MNs y. In the proposed ARP model, we represent this as $obstEffProb(x, y)$. If the distance among the obstructing effects of x and y is greater when compared to the distance among the obstructing effects of MNs in the middle, the MNs are likely to be obstructing. Moreover, the MNs which are obstructing the RP environment among the x and y MNs are elected using the selected possible candidate for the obstruction of MNs which have been established using the previous rounds are denoted as $obstLOSaff([ProbableAff])$. In addition, it is essential to note that the signal being transmitted could become distorted due to the blocking consequences associated with the fresnel-zone ellipsoid (FZE) caused by MNs. These effects can be approximated utilizing the given as (13).

$$z = \left(z_y - z_x\right)\frac{r_{aff}}{r} + z_x - 0.6 s_k + z_t \tag{13}$$

Where, r_{aff} is used for representing the distance among the MNs which are obstructing and transmitting, z_x and z_y are used for representing the height parameter of the MNs x transmitter and MNs y receiver respectively, z_t is used for representing the height of the antenna of the MNs, r is used for representing the distance among the transmitting MNs and receiving MNs and s_k is used for representing the FZE value which is obtained using the given as (14).

$$s_k = \sqrt{ {}^{W r_{aff}\left(r - r_{aff}\right)}/_{r} } \tag{14}$$

Where, W represents the wavelength. It is important to calculate the total height of the complete obstructing MNs before communication, as it helps to provide better transmission of packets. Moreover, if the height of the MN z is higher than the height of the transmitting MN, then the transmitting MN will be obstructed from the MN x and y. From this, the probability of the obstruction effect because of the presence of multiple-obstacles present within the LoS among the MN x and y is given using the (15).

$$L\left(LOS \middle| z_x, z_y\right) = 1 - \mathcal{Q}\left({}^{z - \varphi_z}/_{\omega_z} \right) \tag{15}$$

Where, L represents the probability for the obstruction effect affected by the MN between the transmitting MN and receiving MN, φ_z represents the mean amplification for the obstructing MN and ω_z represents the amplitude standard deviation for the obstructing MN, $\mathcal{Q}(\cdot)$ represents the $\mathcal{Q}$ function.

4. RESULTS AND DISCUSSIONS

This section provides the results for the AMAC protocol. First, the results for the AMAC protocol have been evaluated and compared with the existing MAC (EMAC) protocol [24]. In addition, in this section, in order to determine whether or not the addition of dynamic-network controller (DNC) to the MANET would be beneficial, experiments and comparative analyses have been carried out with both AMAC and AMAC-DNC. The SIMITS simulator [27], [28] is used to develop the RP model, and this RP model is subsequently integrated in One Simulator [29]. For discussing the proposed work, the results and discussion section has been divided into three sections, i.e., propagation overhead, transmission overhead, and ARP study similar to work presented in [9], [12]. Moreover, for the ARP study, three scenarios have been considered, mainly, city, expressway and semi-urban [24], [28]. For evaluating the propagation overhead, the throughput is considered and for evaluating the transmission overhead, the packet loss has been considered for different MANET devices densities. The parameters considered for the simulation have been given in the Table 1.

Table 1. Simulation parameter

Network Parameter	Value
Network Size	50km *50km
Number of MANET nodes	10, 20, 40 & 80
Number of MRT	1 per region
Modulation scheme	QAM-64
Mobility of MANET nodes	3 cycle per frame
Coding rate	0.75
Bandwidth	27 Mbps
Data channel size	6
Control channel size	1
Dynamic Network controller per MRT	1
Time slot size	8 μs
Message information size	27 bytes
Radio propagation mobility model	Adaptive radio propagation such as expressway, city and semi-urban
MAC used	EMAC & AMAC

4.1. Propagation overhead

In this section, the propagation overhead for the proposed EMAC and AMAC protocol has been discussed. For evaluating the propagation overhead, the achieved overall throughput by the different MNs have been considered. When the value of throughput is higher, the propagation overhead performance is better, that is, the propagation overhead is decreased. The propagation overhead has been evaluated by varying the MNs to 10, 20, 40 and 80 and evaluating in terms of throughput. For 10, 20, 40 and 80 MNs, the AMAC protocol performs better by 4.11%, 17.22%, 11.10%, and 24.88% respectively in comparison to the EMAC protocol. There is an average improvement of propagation overhead by 14.45% in comparison to the EMAC protocol. The results for the propagation overhead for the AMAC and EMAC protocol has been shown in the Figure 2. Further, as seen in the Figure 2, the AMAC protocol performs better in comparison to the EMAC protocol for the propagation overhead. To enhance the performance of the communication network, the proposed ARP model has introduced the DNC to optimize the contention window size in dynamic manner according to current traffic demands. The results for the propagation overhead by using the AMAC and AMAC-DNC has been given in the Figure 3. The propagation overhead has been evaluated by varying the MNs to 10, 20, 40 and 80 and evaluating in terms of throughput. For 10, 20, 40 and 80 MNs, the AMAC-DNC protocol performs better by 7.27%, 3.20%, 12.40%, and 11.56% respectively in comparison to the AMAC protocol. There is an average improvement of propagation overhead by 8.61% in comparison to the AMAC protocol. The results show that by using the AMAC protocol, the propagation overhead is less, but for managing the different traffic demands, the AMAC-DNC model performs better.

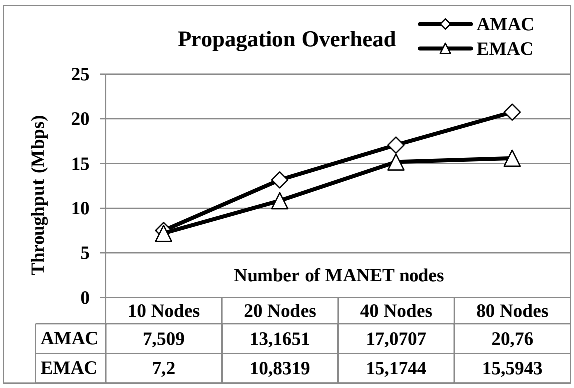

Figure 2. Propagation overhead

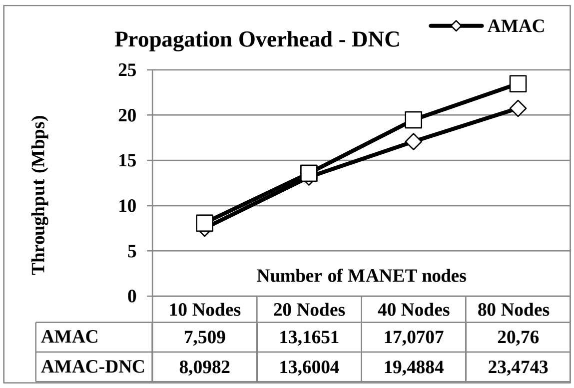

Figure 3. Propagation overhead with DNC

4.2. Transmission overhead

In this section, the transmission overhead for the proposed EMAC and AMAC protocol has been discussed. For evaluating the transmission overhead, the overall packets lost by the different MNs have considered. When there is less loss of packets by the MNs, the transmission overhead performance is better, that is, the transmission overhead is decreased. The transmission overhead has been evaluated by varying the MNs to 10, 20, 40 and 80 and evaluating in terms of loss of packets. For 10, 20, 40 and 80 MNs, the AMAC protocol performs better by 38.46%, 29.16%, 8.17%, and 28.98% respectively in comparison to the EMAC protocol. There is an average improvement of propagation overhead by 26.19% in comparison to the EMAC protocol. The results for the transmission overhead for the AMAC and EMAC protocol has been shown in the Figure 4. Further, as seen in Figure 4, the AMAC protocol performs better in comparison to the EMAC protocol for the transmission overhead. To enhance the performance of the communication network, the proposed ARP model has introduced the DNC to optimize the contention window size in dynamic manner according to current traffic demands. The results for the transmission overhead by using the AMAC and AMAC-DNC have been given in the Figure 5. The transmission overhead has been evaluated by varying the MNs to 10, 20, 40 and 80 and evaluating in terms of loss of packets. For 10, 20, 40 and 80 MNs, the AMAC-DNC protocol performs better by 62.5%, 35.29%, 14.38%, and 11.21% respectively in comparison to the AMAC protocol. There is an average improvement of transmission overhead by 30.84% in comparison to the AMAC protocol. The results show that by using the AMAC protocol, the transmission overhead is less, but for managing the different traffic demands, the AMAC-DNC model performs better.

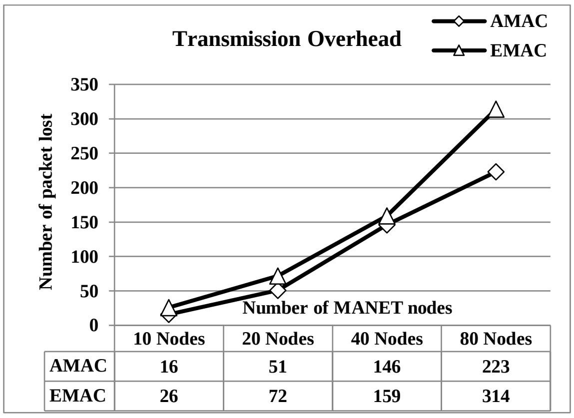

Figure 4. Transmission overhead

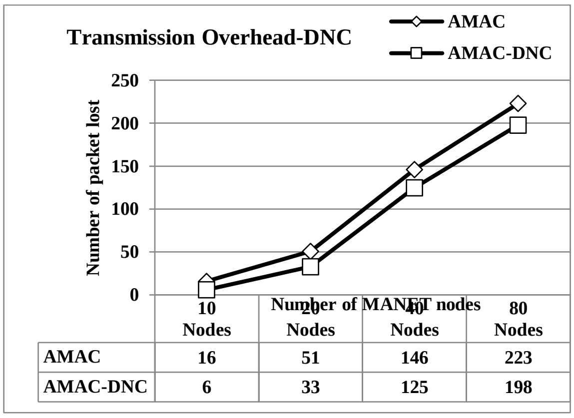

Figure 5. Transmission overhead with DNC

4.3. Adaptive radio propagation study

In this section, the propagation overhead for the different ARP mobility models have been discussed. For evaluating the propagation overhead, the achieved overall throughput by the different mobility models such as city, expressway and semi-urban have been considered. The propagation overhead has been evaluated by considering the throughput and simulation time. The results for the propagation overhead for different ARP mobility model has been given in the Figure 6. The results show that the propagation overhead for the different ARP models, i.e., city, expressway and semiurban fluctuates as the time passes. In the initial, the expressway shows better propagation overhead but drops as the time passes. Further, the city model shows better propagation overhead in comparison to the expressway. Finally, the semiurban model shows less throughput, hence the propagation overhead is more. The city, expressway and semiurban achieved an average propagation overhead of 12.62 Mbps, 12.04 Mbps and 9.76 Mbps. The results show that in the city, the proposed AMAC provides better propagation overhead. Moreover, the transmission overhead for the different ARP mobility models have been discussed. For evaluating the transmission overhead, the overall packets lost by the different mobility models such as city, expressway and semi-urban have been considered. The transmission overhead has been evaluated by taking packet loss and simulation time into consideration. The results for the transmission overhead for different ARP mobility models have been given in the Figure 7. The results show that as the time passes the transmission overhead increases for the different ARP models. The results show that the city model show less packet loss due to which the transmission overhead is better in comparison to the expressway and semi-urban models.

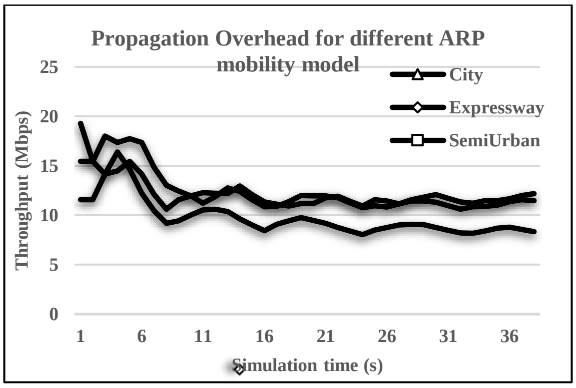

Figure 6. Propagation overhead for different ARP mobility model

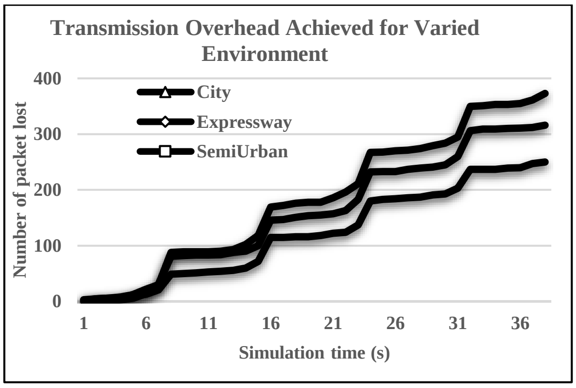

Figure 7. Transmission overhead for different ARP mobility model

5. CONCLUSION

In this work, an adaptive radio propagation (ARP) model has been presented for the city, expressway and semi-urban scenarios. In this model, first, an adaptive medium access control (AMAC) protocol has been presented for reducing congestion and improving network performance efficiency. Further, a dynamic network controller (DNC) has been presented for optimizing the contention window size in dynamic manner according to current traffic demands. The proposed work has been compared with the EMAC protocol. The proposed work has also been compared without and with DNC, i.e., AMAC and AMAC-DNC. The results have been evaluated in terms of propagation overhead and transmission overhead. Finally, ARP model for different mobility scenarios using the proposed work has been studied. The results show that there is an average improvement of propagation overhead and transmission overhead by 14.45% and 26.19%. Also, when the AMAC and AMAC-DNC were compared with each other, the AMAC-DVC showed an average improvement of propagation overhead and transmission overhead by 8.61% and 30.84%. In the ARP study it can be seen that the city model achieves better propagation overhead and transmission overhead in comparison to the expressway and semi-urban model.

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